

IMPACT OF GLOBAL WARMING ON CLEAN ENERGY IN ASIA

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INTRODUCTION

Asia is recovering from the economic crisis of the late 1990s, and a return to moderate or higher economic and energy growth rates is expected over the next two years. Along with a return to higher levels of economic growth will be increased attention to Asia's serious environmental problems. Particularly among developing Asian economies, high levels of energy-related air pollution are largely the result of the use of dirty fuels and lack of adequate energy conversion technologies and emissions control equipment. Coal is responsible for most local and regional airborne pollution, and is also a major producer of greenhouse gas (GHG) emissions.

As shown in Figure 1, coal is the dominant primary energy source in Asia, closely followed by oil, with clean natural gas a distant third. An important factor in coal's importance in the energy mix is its status within Asia's energy reserves; coal accounts for more than 90 percent of these reserves, as shown in Figure 2.

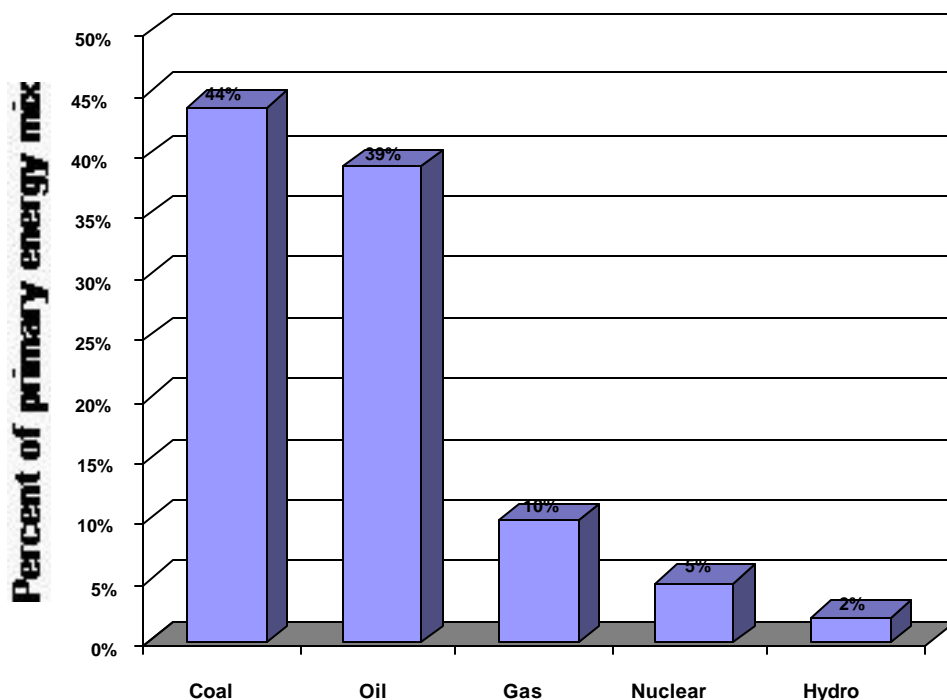


Figure 1. Primary energy by fuel types in Asia

¹ Special thanks are given to Mr. Saengroaj Srisawaskraisorn for his contributions to the paper, particularly in the preparation of figures.

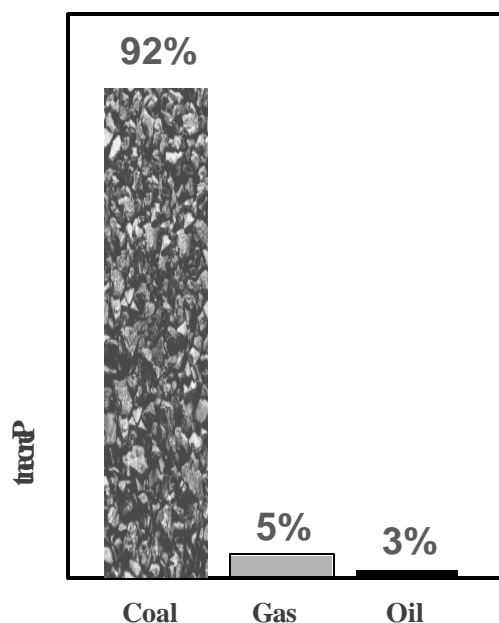


Figure 2. Shares of fossil fuel reserves in Asia

Coal is dirtiest fossil fuel when burned without proper pollution control equipment, and is the leading cause of three important airborne pollutants in Asia: particulates, SO₂ and CO₂. Based on the RAINS-ASIA model, Figure 3 shows the generalized distribution of SO₂ deposition across Asia, and clearly shows high levels of SO₂ deposition across much of eastern China and neighboring economies. Model projections to 2020 under a business-as-usual scenario show worsening SO₂ pollution across Asia. As shown in Figure 4, the two largest coal consumers, China and India, account for 80%² of Asia's SO₂ emissions, and therefore are at the core of any regional strategy to control SO₂ emissions.

It has been often suggested that governments in developing economies give priority to high rates of economic development, and are likely to defer introduction and enforcement of strong environmental legislation. However, air pollution has a substantial cost to economies through increased health risks and premature deaths, as well as damage to agricultural crops, forests and water supplies. Figure 5 shows air pollution as the number one preventable health risk in China. In India, air pollution is believed to be among the three most important preventable health risks. The World Bank estimates that the total cost of pollution in China exceeds US\$50 billion per year.³ The total cost for Asia is not known, but probably exceeds \$75 billion per year. Given the high costs of pollution in Asia and the availability of relatively low-cost options to reduce pollution, the national benefits from investment in environmental controls are high.

²Estimates vary on the amount of SO₂ produced by China and India, and the estimates in Figure 4 should be considered approximations.

³World Bank, 1997, Clear Water, Blue Skies.

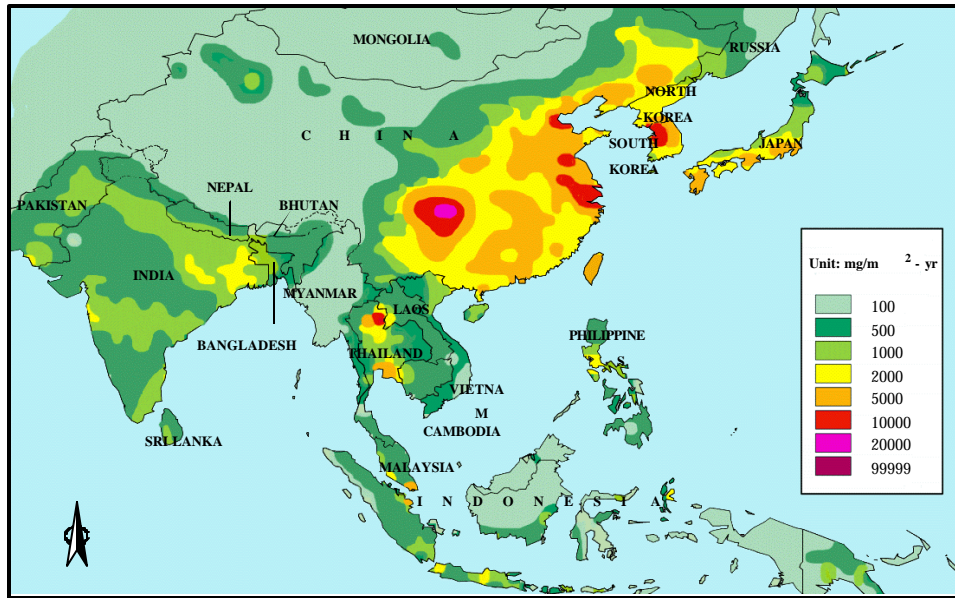


Figure 3. Sulfur deposition in Asia in 2000 (*modified from RAINS -ASIA model, 1994*)

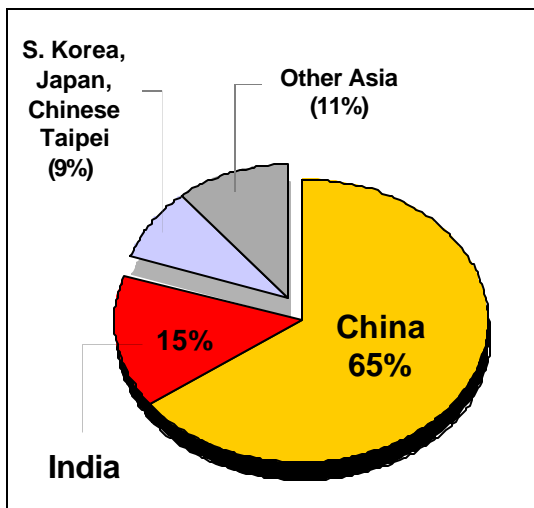


Figure 4. Estimated SO_2 emissions in Asia in 1998

(*source: Charles Johnson, East-West Center, February 2000*)

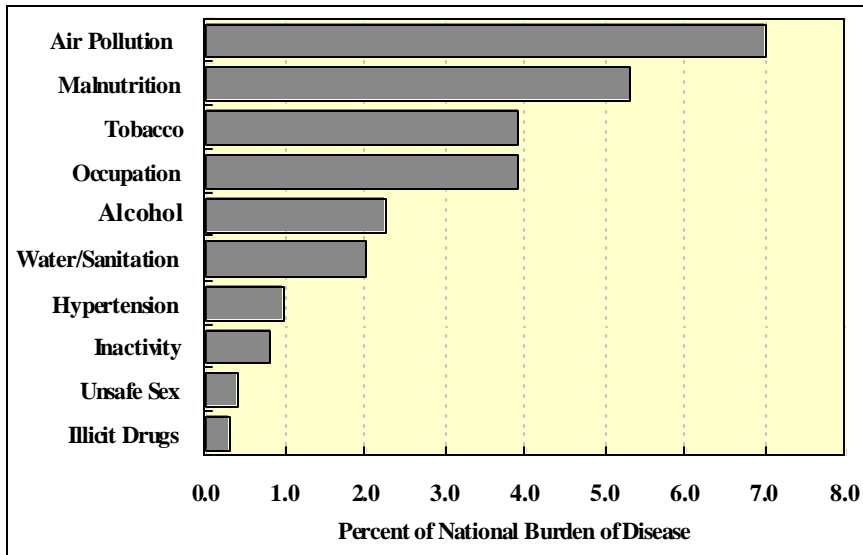


Figure 5. Impact of major risk factors in China

Why Asia has High Pollution Levels

The simple answer is that the majority of energy-burning technologies in developing economies of Asia do not employ adequate pollution control technologies, and high-ash and/or high-sulfur coal is used so extensively across Asia. The high reliance on coal is partially explained by the fact that coal accounts for more than 90% of Asia's fossil-fuel reserves, as shown in Figure 2, and the largest shares of these reserves are in the two largest developing economies, China and India.

Historically, the transition to cleaner, less polluting technologies has correlated broadly with levels of economic development, with richer economies enforcing stricter environmental standards. However, this generalization appears to be changing in some important developing economies, including China, which increasingly are introducing and enforcing tighter pollution standards. Two important factors in the control of growing levels of pollution in developing Asian economies are the timely introduction of more advanced energy and environmental technologies, and the substitution of cleaner fuels.

Future Growth in Energy Consumption in Asia

The overall growth in primary energy consumption in Asia is projected to average between 3.8 and 4.5% per year in the 2000–2020 period. New renewable energy technologies are likely to have double-digit growth rates, but from a very small base, and are likely to account for 3–5% of the primary energy market by 2020. Natural gas is projected to have the highest growth rate among fossil fuels, at between 5.5 and 6.2% per year, increasing its primary energy share to between 13 and 17% by 2020. The growth rates in oil consumption are exceedingly difficult to project because of the looming massive increase in automobile demand as hundreds of millions of people in Asia reach middle-class income levels over the next two decades. Annual automobile purchases of about 12 million are projected to triple or more by 2020, taking oil's primary market share ahead of coal.

The demand for coal is expected to be dominated increasingly by the growth in demand for coal for electricity generation. Figure 6 shows the base-case forecast of growth in coal consumption in Asia until 2020. As shown in Figure 6, coal consumption is projected to double between 1998 and 2020, with China and India accounting for the largest share of the growth.

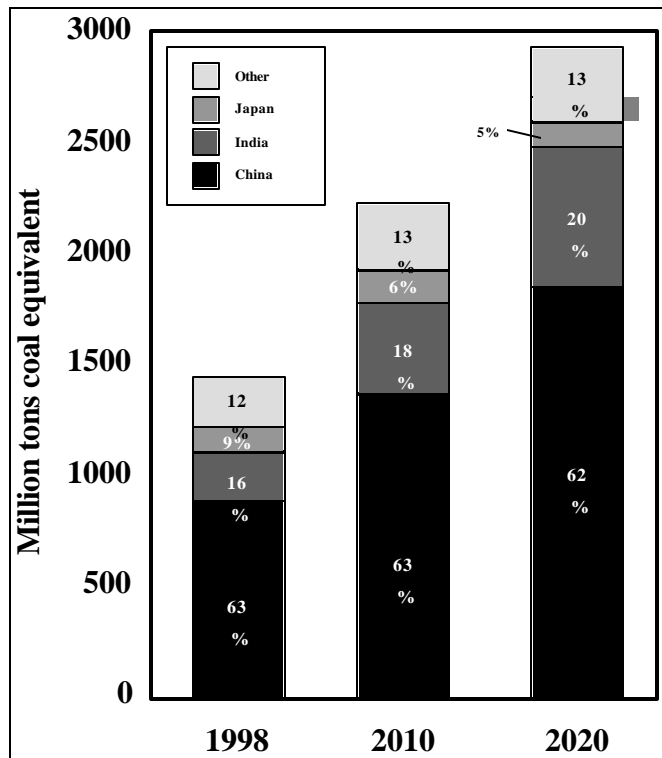


Figure 6. Asia-Pacific Coal Consumption: 1998–2000

Recent large unexpected reductions of more than 200 million tons in China's coal production suggest greater caution in making long-term coal projections for China. A combination of factors appears to have contributed to this reduction, including the closing of more than 20,000 smaller coal mines, a slowdown in the demand for coal, efforts to reduce the large stockpile of coal in China, and a substantial, rapid shift to higher-energy-content coal being used in China. The recent low growth rate in electricity demand in China is not expected to last, and higher growth rates are highly likely, causing a return to moderate growth in coal consumption.

The plausible combination of a rapid introduction of alternative fuels, particularly natural gas, with major improvements in energy technologies and much stricter enforcement of environmental legislation, could result in increases of as little as 70% in Asia's coal consumption over the 1998–2020 period. Under the optimistic growth scenario, coal consumption could more than double over the 1998–2020 period.

The key conclusion is that, under likely scenarios, coal consumption will double within 20 to 25 years, and coal's share of the energy mix will decrease to less than 40%. The environmental consequences of increased coal use will worsen without widespread use of

clean-coal technologies, growth in the use of cleaner fuels, and improvement in energy efficiency in Asia.

Comparative Electricity Costs

Figure 7 shows current relative electricity costs for new power plants built in Asia, excluding Japan, where costs are much higher. The comparisons in Figure 7 are useful for relative comparative cost purposes, and do not include land costs or taxes. It is emphasized that actual costs vary considerably between countries and sites, and site-specific factors often change rankings among technology and fuel choices. For example, costs in Japan are much higher than in the rest of Asia, typically double or more those shown in Figure 7.

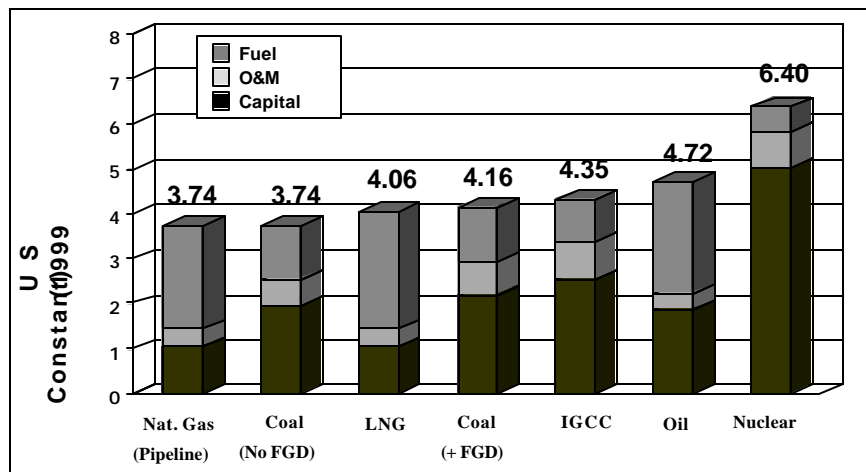


Figure 7. Relative electricity costs of new power plants in Asia (excluding Japan)
(note: actual electricity generation costs vary widely depending on specific plant locations)

As shown in Figure 7, the lowest-cost electricity comes from pipeline natural gas and coal-fired coal plants without flue gas desulfurization (FGD).⁴ Liquefied natural gas appears to be slightly cheaper than coal-fired plants with FGD. However, because most LNG contracts require long-term commitments and are based on volatile oil prices that add risks to projects, private investors typically select coal-fired plants for base-load generation over LNG plants. Integrated gasification combined cycle (IGCC) plants for coal are the most promising long-term alternative for coal in a “GHG-restricted” environment. To date, IGCC costs are significantly higher than costs for conventional coal-fired plants, but the difference is decreasing. Electricity costs from oil-fired plants are considerably more expensive than coal, but oil’s versatility assures a small share of the power market, particularly for small plants and industrial boilers. Private power companies invest in new nuclear power plants only when governments encourage such plants through policies and/or subsidies. Nuclear power is not competitive with coal or natural-gas-fired power plants when evaluated under the same assumptions about load

⁴ Costs for a mine-mouth coal-fired plant or a combined-cycle gas-fired plant near the gas field would be lower than those assumed in the model analyses in Figure 7.

factors and lending terms for loans. Nuclear power plants do not burn fossil fuels, and therefore do not release CO₂ during operation. The combination of much higher costs for nuclear power and radioactive risks in the fuel cycle and beyond, limit the use of nuclear power in most countries.

Climate Change and Greenhouse Gas Emissions

The previously discussed local and regional environmental problems are solvable at added costs of 0.4–0.8 US cents/kWh with the addition of pollution-control equipment, and/or switching to low-sulfur coals.² The most difficult challenge that threatens coal's long-term future is the effect of present and future international agreements on reduction of GHG emissions, most importantly CO₂.

² In some plants pollution control equipment can add 1.0 US cent/kWh, but better performance is projected for new plants.

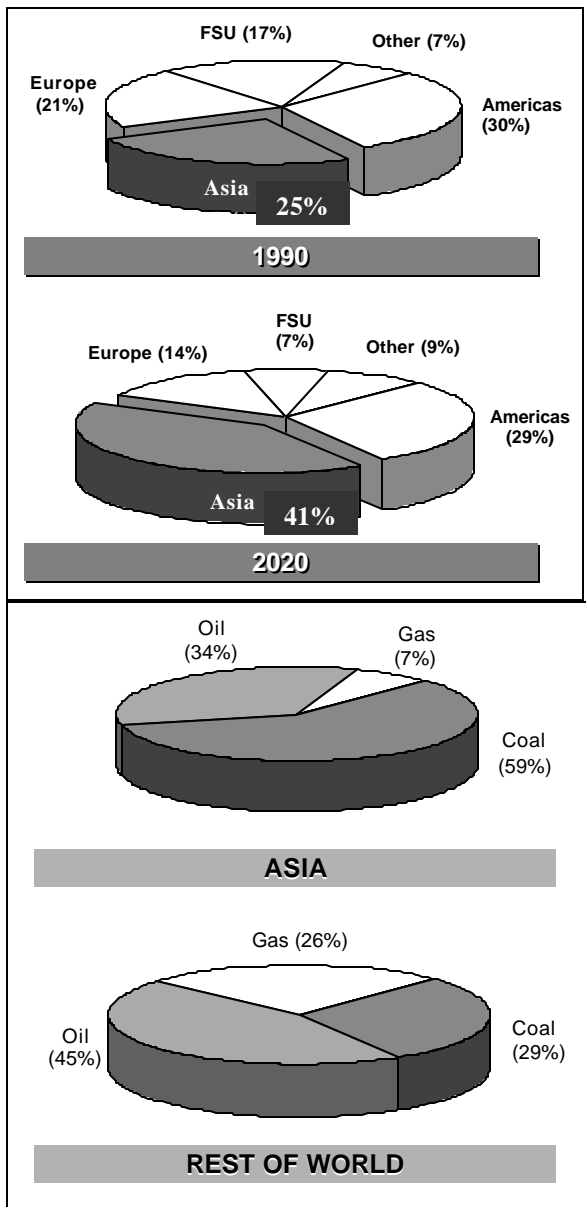


Figure 8. (left) Carbon emissions from fossil energy.

Figure 9. (right) Carbon emissions by fuel type in 2000

(source: modified by C. Johnson and S. Srisawaskraisorn from Energy Information Administration, 1999).

Figure 8 shows the growing importance of Asia as a source of the world's carbon emissions from fossil energy. Asia's share of world carbon emissions is projected to increase from 25% in 1990 to 41% in 2020. Asia increasingly will become the focus of attention for global agreements intended to control carbon emissions. As shown in Figure 9, coal accounts for 59% of fuel-related carbon emissions in Asia, compared to 29% in the rest of the world. The high percentage of carbon from coal in Asia is due to the higher carbon content of coal relative to other fossil fuels, and the high percentage of

coal consumed in Asia. As governments search for ways to reduce carbon emissions, coal will come under increased scrutiny because it is the leading source of GHG emissions.

How Serious are Governments About Reducing GHG Emissions?

To date, 84 parties to the UN Framework Convention on Climate Change have signed the historic Kyoto Protocol to reduce GHG emissions. This Protocol commits 39 industrialized countries to GHG targets by 2008–2012, mostly ranging from 6 to 8% below 1990 emission levels. Developing countries have not agreed to specific GHG targets for various reasons, most importantly the potential negative impacts on sustaining economic growth, and the fact that industrialized countries produced most of the GHGs that are causing global concern about climate change.

As shown in Figure 10, 22 countries, representing 26% of countries that signed the 1997 Kyoto Protocol, had ratified the Protocol by January 2000. The Protocol comes into force after 55 economies have ratified it, including Annex I (industrial) economies, which accounted in total for at least 55% of carbon emissions in 1990. However, Figure 11 shows that the total carbon emissions from economies that have ratified the Protocol account for an insignificant 1.3% of the carbon emissions from all economies that signed the Protocol. The evidence in Figure 11 suggests that the Kyoto Protocol in its present form may not officially come into force for many years.

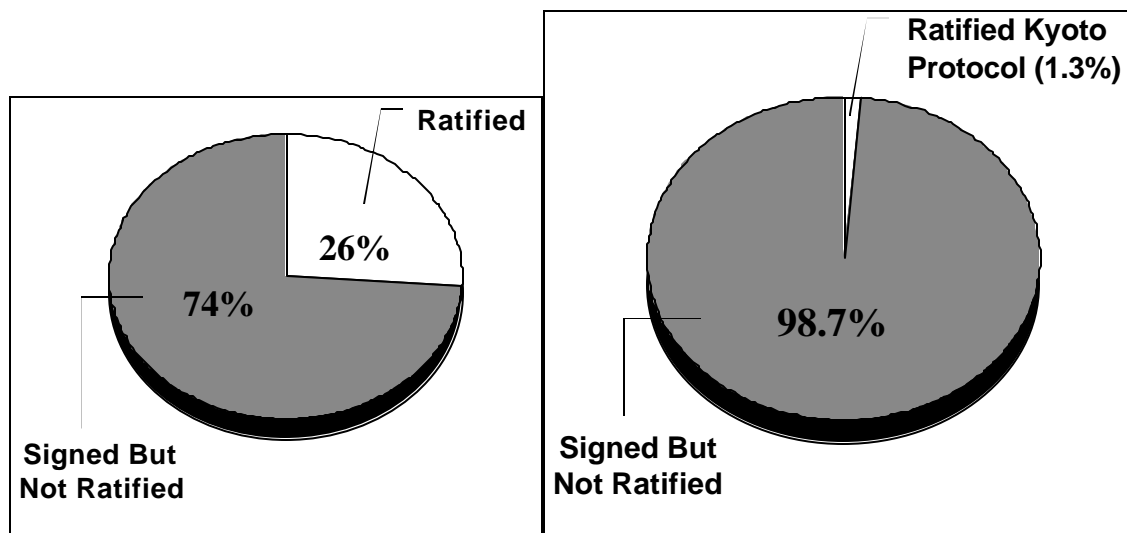


Figure 10. (left) Shares of countries that have ratified the Kyoto Protocol

Figure 11. (right) Shares of world carbon emissions in 1997 (source: UNFCCC 2000)

However, it should not be concluded that the Kyoto Protocol is a complete failure. The GHG emission commitments of governments at Kyoto, although perhaps not rectifiable, appear to have been an important catalyst for voluntary government actions to reduce growth in GHG emissions. Based on qualitative assessments by this author of actions of the larger Asian economies, it is this author's view that *ratification of the Kyoto Protocol is not critical to reducing the growth rate of GHGs* (Figure 12). All of the APEC economies in Asia have policies to increase energy efficiency and reduce GHG

emissions. China, for example, has an ambitious plan to improve combustion efficiency at its coal-fired power plants and industrial boilers, to upgrade the quality of its coal, and to develop a national natural gas network. It is unrealistic to believe that GHGs will be stabilized near 1990 levels by 2008–2012, as sought under the Kyoto Protocol. However, the upward trajectory of GHG emissions already appears to be slowing as a result of a combination of factors, including the voluntary actions of governments.



Figure 12. Relevance of the Kyoto Protocol

The Future of Clean Energy in Asia

With or without ratification of the Kyoto Protocol, Asia is likely over the next two decades to continue to make progressive gains in reducing the growth rate in GHG emissions. As previously discussed, the carbon reduction targets agreed to at Kyoto are unlikely to be achieved by 2008–2012. Attention would be better directed toward a sound, linked economic-environmental strategy that sustains energy efficiency improvements and increases the percentage of low-carbon fuels in the energy mix.³ Government's most effective role is to help establish and enforce sound environmental and energy efficiency standards, and to allow competitive market forces to determine the lowest-cost energy and technology path. The opportunity for the APEC experts groups is to facilitate the roles of both government and private sectors.

The sources of capital flows have dramatically changed over the past decade as shown in Figure 13, with private capital increasing from 44% of capital flows in 1990 to an estimated 85% in 2000. There can be little doubt that successful transfer of advanced clean-energy technologies and the development of clean fuel alternatives, particularly an Asia-wide natural gas system, will depend primarily on private-sector investments and

³ It is premature to assess the commercial potential for CO₂ recovery and sequestration. Because costs may add 50% to the electricity costs shown in Figure 7, this option may only become important if those costs can be substantially reduced, or in a highly "carbon constrained" world.

not government assistance. Increasingly, the role of governments is to focus on establishing sound environmental laws and investment climates that encourage private capital.

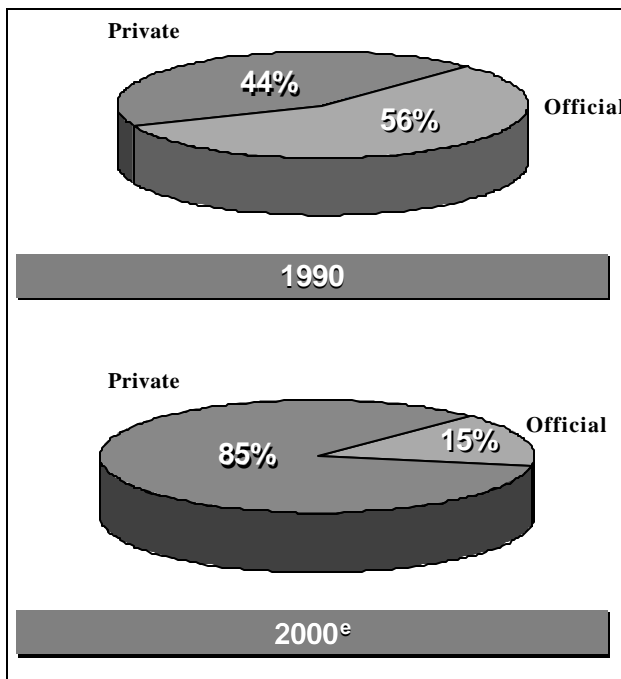


Figure 13. Capital flows to developing countries in 1990 and 2000

(sources: World Bank, 2000; C. Johnson and S. Srisawaskraisorn, February 2000).

CONCLUSIONS

The health costs of energy-related pollution are high over large parts of Asia. In China, for example, air pollution is the number one preventable health risk. Coal is both the leading cause of local and regional pollutants that have the highest health risks, and the largest contributor of CO₂ emissions among fossil fuels. The share of coal in the primary energy mix is projected to decrease gradually over the years between 2000 and 2020, with natural gas growing at the fastest rate among fossil fuels. Also, as a consequence of rapid growth in automobile use in Asia, oil is likely within two decades to displace coal as the leading fossil fuel in the energy mix. Nevertheless, Asia's coal consumption is projected to double by 2020 or 2025, further necessitating the need for sound Asia-wide environmental standards.

No important GHG-emitting economy has ratified the Kyoto Protocol, and it appears unlikely that it will come into force in its present form for many years. However, it is suggested in this paper that ratification of the Kyoto Protocol is not critical to reducing the growth rate of GHGs in Asia. This is because all significant GHG-emitting nations in Asia are already developing and implementing programs to reduce the rate of growth in GHG emissions. In addition, tightening environmental regulations in Asia are encouraging the use of clean, energy-efficient technologies, and the conversion to cleaner fuels—changes that will slow the growth in GHG emissions.

The goal of stabilizing GHG emissions below 1990 levels by 2008-2012 is highly unlikely. Sound environmental and energy-efficiency policies and legislation in Asia, combined with greater reliance on competitive markets, will accelerate the transition to a cleaner energy mix that includes clean-coal technologies and a higher percentage of low-carbon fuels. The challenge is how to make APEC the best regional forum of policymakers and experts for exchanging technical, economic and policy information on how best to achieve these objectives.